

A NOTE ON SOME NATURAL BARRIERS IN BURMA

BY

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(*With a map*)

This paper was drafted before I saw Smythies's 'Birds of Burma'. His introduction contains a scheme for dividing Burma into a number of faunal districts. I am not a systematist, and do not really understand the relative importance of various differences, generic, specific and subspecific. I tried to make lists of birds peculiar to one or more of his districts and could not do so even to my own satisfaction. While I agree that there are such areas, I am not competent to deal with them. I therefore reverted to my original intention, to discuss the barriers which separate certain areas of which I have experience rather than the areas themselves and their fauna.

Col. J. K. Stanford was good enough to lend me reprints of his various papers about the birds of north-east Burma. While they settled any remaining doubts about my ability to deal properly with faunal areas in Burma, combined with Smythies they left me uncertain about the relationship between natural barriers and distribution limits.

Factors limiting distribution are many. One curious case is the Elf Owl *Micropallas whitneyi* in arid North America. It nests in the holes of two woodpeckers, *Centurus uropygialis* and *Colaptes chrysoides mearnsi* in giant cactus *Cereus giganteus*. The woodpeckers make holes in other species and places, but the owls do not use them; not all cactus areas are within the range of the woodpeckers, but outside it the elf owl is not found (Allee, p. 234). Birds of really high altitudes occur in north-east Burma only; it seems essential for them to be near snow. The same applies to the Takin *Budorcas taxicolor*. At the other extreme, many tropical Malaysian birds extend into Burma in Tenasserim, sometimes as far north as Karenni. The limiting factor seems to be temperature and/or humidity. In the south there is no physical barrier although with the blood pheasants, etc. in the north it might be held that the low ground—a comparative term as their low limit seems to be about 7,000 ft.—forms a barrier and prevents spreading. They must apparently have higher ground, at least 10,000 ft. within reach. At lower altitudes, many hill species do not descend below a certain level, often 2,500-3,000 ft., while other forms do not go higher than this. The Dry Zone is a special case where a few birds and the thamin *Cervus eldi* seem to be limited to areas of excessively small rainfall, in fact to conditions nearing those of a desert.

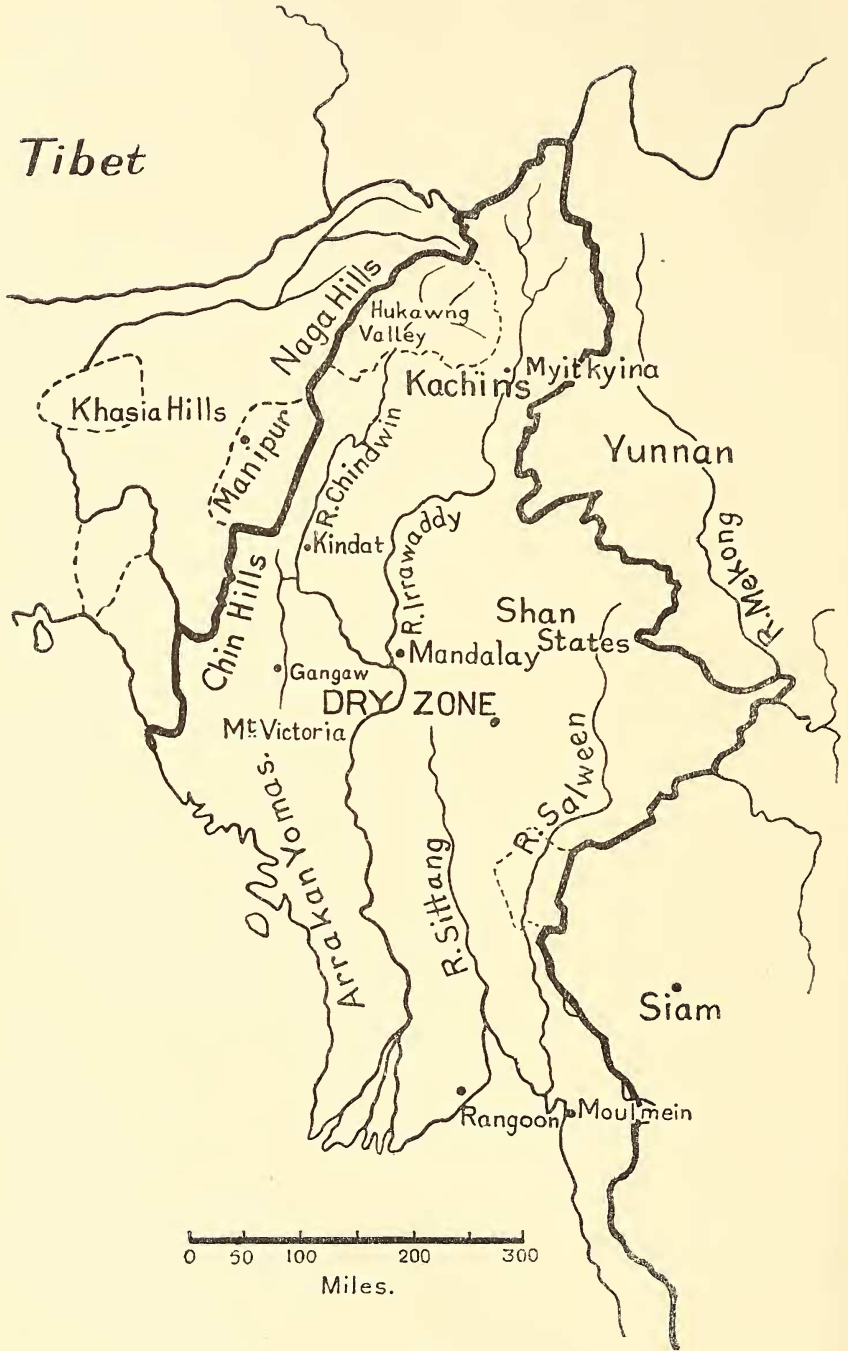
A temperature or humidity change when it is a matter of latitude is difficult to see as a physical barrier to the extension of the range of a species. One requires at least a rainfall map with isotherms.

The factor may operate on the animals themselves in that they do not thrive outside certain limits, or on their food or their habitats. Certain Hawaiian honey eaters, Drepanids, live in dense tropical rain forest. A road was cleared through, and although they live on both sides, they are said never to cross the gap. An American humming bird *Agyrtria boucardi*, is common in one place for a month when a particular flower is in bloom. In nearly 100 years it has not been found elsewhere, nor in the other 11 months of the year (Griscom, p. 49, 73). There are other similar cases. We can see a gap in dense forest or a blooming flower; they are limiting factors but hardly natural barriers.

The most obvious natural barrier is the sea. We can understand that an animal cannot cross it unless it can fly—there are exceptions, animals dispersed on drifting rubbish—and that powers of flight must be of a special kind; but the willow warbler *Phylloscopus trochilus* for instance looks an unlikely candidate for crossing the English Channel, and a small gull with a broken wing once swam the Atlantic Ocean (Hickey, p. 38). In the case of penguins and seals, etc., it is the land which is the barrier. The Amazon, and even its bigger tributaries limit some birds, and Grand Canyon, a wrinkle on the face of the earth a mile deep, has different subspecies of some small mammals on each side. When we come to mountains, we seem to be on solid ground. One cannot very well miss the Himalayas, the Rockies or the Andes with their altitudinal changes in vegetation. We can see these and the change in temperature may be obvious in a day's march. The same applies in a lesser degree to the Chin Hills and the Maymyo plateau. But it is not a physical impossibility for a bird or a mammal to cross mountains. They can fly in short hops or walk the whole way—we do it ourselves. Small warblers have been found dead at very great altitudes (18,000 ft.) on migration, although many migration routes run along instead of over hills. It is not the mountains in themselves which set limits, but the conditions which they produce. It is the same with the Dry Zone; the Irrawaddy-Chindwin valley is bounded on the east and west by high ground, but from the south northwards we get first tropical conditions as far as Prome, then extreme aridity to Monywa followed by a wet subtropical belt in the north, without any obvious physical change in altitude or conformation.

One is driven to the rather illogical conclusion that a natural barrier must be something which can be seen and which is a natural feature which can be shown to limit the range of a number of species. Latitudinal changes in temperature are gradual while the tolerances of different species vary; so their limits also vary and do not result in the more or less definite demarcation line found with altitudinal changes. This does not perhaps apply to the far north where a certain isotherm not very much above freezing point thaws the ground and/or allows vegetation and insects to become active and so provides cover and food which is absent below it.

A mountain range, while it is a barrier to plains species, forms a dispersal route for those of higher altitudes, and the same is true of other barriers.



BURMA

INTRODUCTION

a. General

When stationed in the Upper Chindwin Forest Division, Burma, 1912-15, I collected eggs which are mostly in Stuart Baker's collection in the British Museum, and also made collections of mammal skins for the Society's Mammal Survey of India, Burma and Ceylon. They came mainly from between the Chindwin and the Manipur boundary, which here runs along the ridge of the Chin Hills, but included some from the east bank of the river. Shortridge and Macmillan, the Society's collectors, came to the district for about three months in 1914, and I handed over to them about 100 skins which contained some new species, e.g. *Callosciurus macmillani*. Unfortunately my name was erased or cut out from the labels, which makes it necessary to see them to identify the skins by the writing, the date and the locality, as I was using Shortridge's printed labels. I have seen some in the British Museum, including the type of *C. macmillani*.

b. Geography

To understand the problem, a sketch map is given, simplified to bring out the essentials. The Chindwin-Irrawaddy Valley—broken ground with swamps but all under 2,000 ft. elevation—thrusts itself up to or nearly up to the Hukawng Valley. It is about 100-150 miles wide, including the two flood plains, that west of the Chindwin not being very wide. From a point north of Monywa nearly down to Prome, the rainfall is very low, 8-12 in. only, and temperatures are very high, up to 120°F. at times. This is the Dry Zone, with profoundly modified vegetation, which is an even more formidable barrier to the dispersal of hill species than the wetter and cooler low ground in the north and south with about 80 in. of rain.

The hills form an elongated horse-shoe: from the north of the Hukawng Valley, the Naga Hills, Manipur and the Chin Hills run down to Mt. Victoria (10,400 ft.) on the west at heights of 5,000-7,000 ft., with Saramati in the north, 12,500 ft., unexplored in 1915¹. To the south this ridge is continued at a lower level as the Arakan Yomas. To the west lie the Khasia Hills, with no considerable rivers between, forming part of the same mountain mass. To the east, the Kachin Hills, the Shan States and Karenni are parts of a similar ridge or plateau of high altitude, very high indeed in the north-east where altitudes are greater than in the west. There are various high points over 5,000 ft. at least down to the level of Moulmein where Muleyit Mountain is 6,300 ft. Others are Thandaung, near Toungoo, and Taunggyi. East of this again lies the Salween river and beyond that the Mekong; the high ground between these rivers may give another dispersal route for hill species. The mountains north and west of the Hukawng Valley run into the Himalayan system, and to the east, into the Chinese mountains.

¹ Still largely so.—Eds.

A cross-section anywhere across the Irrawaddy-Chindwin Valley gives much the same features: High ground over 3,000 ft. to the west, the Naga-Chin Hills; then 150 miles of ground under 2,000 ft., the valley, followed by the Kachin-Shan ridges and plateaux. To the east again is the Salween with a high ridge beyond it and the Mekong beyond that again.

Between the Manipur-Chin Hills ridge and the Chindwin, the Yu and Myittha rivers form the Kabaw Valley and its extension to the south, low lying flats with a ridge of hills not over 3,000 ft., the Yomas, between them and the Chindwin. (Yoma is the generic term in Burmese for any ridge or hills.) The Chindwin Yomas are well wooded and with the Kabaw Valley, serve to isolate the Chin Hills high level fauna; that of the Yomas is of a low altitude type.

There are no big towns in the west, Kampetlet, Haka, Falam and Fort White being in 1915 little more than Military Police posts, although Imphal in Manipur is bigger. In the east, Kalaw, Taunggyi, Maymyo and Mogok are all big towns from which collections have been made.

In the Dry Zone, Mt. Popa, 5,000 ft., forms an island habitat with comparatively high rainfall.

The Chindwin is shorter than the Irrawaddy, and was said by captains of the Irrawaddy Flotilla Company to be faster. It is suggested by Shortridge (Wroughton, 1916 *a*) that islands formed in the Irrawaddy by cutting out bends were connected first with one bank and then with the other, thus allowing animals to pass over the river. Such islands are certainly uncommon on the Chindwin if they have existed at all to an important degree. I have seen what was reputed to be one of them on the Irrawaddy, where a big bend had been short-circuited and later joined up to the opposite bank, a cold weather land bridge being formed in a very short time. All appearances pointed to this having occurred, and if so a considerable bit of land, 2 or 3 square miles, had been transferred from one bank to the other, with its inhabitants. Whatever the reason, the Chindwin acts as a natural barrier to the distribution of squirrels; with one small exception noted below, the species and subspecies occurring on each bank are distinct. The Chindwin, although not as big as the Amazon, is still a big river, and it is fast.

But in the same area there is another type of barrier. The flood plains of the two rivers, separated by over 100 miles of low-lying land, cut off the hills on the west from those in the east, and the only high ground link is through the Hukawng Valley in the north. This effectively limits the distribution of animals living at 3,000 ft. and over.

c. Dispersal Routes

From this it will be seen that the normal routes for dispersal are north and south. The western ranges, Naga-Manipur-Chin Hills, with Mt. Victoria and the Arakan Yomas, join the west end of the Hukawng Valley mountains. From the east of this valley, the snow-capped tops of the northern mountains near Fort Hertz (Putao) run

south with the high points mentioned above right down to Muleyit Mountain, the Kachin Hills, Shan States and Karenni. Except for Stanford's papers on the birds to the north and east of Myitkyina, I have not seen much from this area; I have no good library available. The Vernay-Cutting expedition made extensive mammal collections in the north-east. There is more than one route south giving isolation for differentiation in the Irrawaddy-Salween and Salween-Mekong ridges.

2. SQUIRRELS

Thomas and Wroughton (1916 a) give a list of squirrels found on each bank of the Chindwin. This, amended by subsequent papers (Thomas, 1916, c and d) is given in Table 1. Except for *Ratufa* the squirrels have all been massed as *Callosciurus* by Ellerman who has been followed here. *Ratufa gigantea* is found on both sides of the Chindwin in the north, and Lord Cranbrook tells me that he saw these animals (and gibbons) almost daily up to a pass about 6,500 ft. between the drainages of the Mali-Kha and the N'mai Kha, the west and east branches of the Irrawaddy. Although no barrier was apparent, neither of them was seen or heard beyond this point. In the south on the Chindwin *Ratufa* splits into *R. g. lutrina* on the west and *R. g. fellii* on the east, the latter being a light coloured animal probably produced by the conditions of the Dry Zone; on the west, they spread into the hills, but on the east they are confined between the Irrawaddy and the Chindwin and so are isolated. The Irrawaddy seems to be a barrier for this big squirrel. All the other squirrels are found on one bank or the other only, except for *C. mearsi virgo* at Homalin. The species probably crosses on rafts or boats; I have seen similar ground squirrels elsewhere on bamboo rafts when tied up to the bank; they are sometimes very long and the animal is found round villages and huts so is accustomed to man. Coming down the Chindwin in flood, I have seen very big rafts of rubbish, in extreme cases perhaps an acre in extent, and on them were snakes, lizards, rats and possibly other animals. They may be stable enough to bear a man. I have seen a tiger, a pig, two barking deer and tame elephants swimming in mid-stream, but doubt whether anything smaller could cross alive in this way.

These squirrels show the Chindwin as a barrier to their spread. The river varies considerably in width both from place to place and with the season, from a quarter of a mile to well over a mile. The narrowest places are gorges where the river cuts through a ridge, and here the two sets of squirrels (Table 1) come to within about 400 yds. of each other without mixing. But it is not at such places that rubbish rafts will lodge as the current is too strong; it is the wider stretches which provide shallows suitable for stranding. Here there are usually big areas of elephant grass (kaing) on ground flooded when the river is high, which offer an almost insurmountable obstacle to reaching the trees beyond them. Squirrels can also jump considerable distances and so have every chance to get ashore again when the raft first floats. They are more active than snakes or rats.

3. OTHER SPECIES

In the Chin Hills, I collected considerable numbers of rats (Thomas, 1916 *b* and Wroughton, 1916 *b*). Of these, *Rattus manipulus* is confined to the western hills. All the specimens in the British Museum are from the Chin and Naga group except one, collected by Wickham on Mt. Victoria, which is only an extension of the same ridge. There are 3 skins of *R. nitidus obsoletus* (Hinton, 1918), all collected by me in the Chin Hills. *R. bowersi mackenziei* has been collected in the Chin Hills, the Naga Hills and the Khasia Hills. There are two skins which want comment. One was collected by S. F. Hopwood and the locality on the label is 'Kindat, Chin Hills'. In reports this has been shortened to 'Kindat', which was on the west bank and then the headquarters of the forest division covering the north Chin Hills. Hopwood (not to be confused with J. C. Hopwood) was working near the Chin Hills, 20 to 30 miles west of Kindat, and in three years collecting from Kindat, I did not get this species anywhere in the plains or near Kindat, so I think this specimen came from the same locality as my own, the Chin Hills and not Kindat. The other is a rat collected by Lord Cranbrook, B.M. No. 32.11, 1.83, named *R. b. mackenziei* and labelled 'Hills E. of Nam Tisang'. This again is shortened to 'Nam Tisang' in reports. He tells me that he went north from Myitkyina, and most of his things came from the Adung Valley, 28°10' N. and 97°40' E., just east of the Hukawng Valley, near Putao (Fort Hertz). The skin is listed by Ellerman as the only *mackenziei* skin with the hindfoot not under 52 mm.; it is 52 mm. The hindfeet of *R. bowersi feae* are given as 51-52 mm. but there are or were then only two known specimens, one in the British Museum the type, a spirit specimen, and one in Genoa. I am not qualified to name a disputed rat, but on the hindfoot and perhaps the skull plus the distribution probabilities I think this specimen of Cranbrook's is either the third known skin of *R. b. feae* or a new subspecies.

So we have three rats confined to the Chin-Naga-Khasia hill group to the west of Burma. They are all hill species and presumably the barrier to their spread is the Chindwin-Irrawaddy flood plains and valley. The typical *R. bowersi bowersi* seems to have a wider distribution, including the general area of *mackenziei* in the west and *feae* in the east. I got skins from the same camps as *mackenziei* but have no data as to the possible niches of the two subspecies. It might be elevation as specimens came from above and below my camps at about 3,000 ft., both were said by the Chins to be jungle as opposed to village rats, and to be found near shifting cultivation, but they might differ in preference for, e.g. trees and actual cultivation. The Chins ate them both and say they resemble chicken.

The same type of distribution is found in many birds: for instance *Phasianus humiae humiae* in the west and *P. h. burmanicus* in the east; [*Trochalopteron phoeniceum bakeri* and *ripponni*; *Trochalopteron erythrocephalum erythrotaema* and *woodi*; these two seem doubtful, but have been separated.] *Ianthocincla cineracea cineracea* and *styani*; *Dryonastes galbanus* and *sannio*; *Garrulus leucotis oatesi* and *leucotis*, and many others. Some butterflies and other insects are

limited in the same way, and there may well be other differences in both animals and plants.

In 1914-15, I made small botanical collections in the Chin Hills¹, some of which were damaged when a porter fell into a flooded river and was nearly drowned. Most of the specimens were trees and shrubs. A good botanist (I think either C. G. Rogers or H. H. Haines) told me that they seemed to be allied with India rather than with Burma-Malaya-China, but I have no further details about them and cannot trace the collection which was made officially and presumably went to Dehra Dun. Dr. Frank Kingdon Ward very kindly tells me in a letter that in the north, there are a fair number of identical species in the Alpine regions of Burma and Assam, from the Himalayas to China. But *Primula filipes* and *P. sherriffiana* are found both sides of the Assam Valley (Himalayas and the Naga-Manipur hills) and neither has been found east of the Chindwin. *Rhododendron arizelum* is found in the north of Burma, extending westwards to Tsangpo further north still, and is replaced by *R. macabeum* west of the Chindwin. The lilies east and west are different, *Lilium mackliniae* (Manipur) and *P. nepalense* and *L. wallichianum* (Assam Himalaya) being replaced by *L. primulinum* and *L. bakerianum* east of the Chindwin. He thinks that the flora of Manipur (and hence of the Chin Hills) differs considerably from that of the Htawgaw area in north-west Burma at corresponding altitudes. The former is more closely related to the Himalayan flora across the Assam Valley than to the Chinese flora across the Chindwin and Salween Valleys. The Htawgaw flora is markedly Chinese. There is a wind gap at 4,000 ft. where the Chindwin turns west in the Hukawng Valley, between that valley and the Assam Valley. It may be that a much larger river than the Chindwin, perhaps the Dihang, flowed through it in glacial or pre-glacial times and constituted a formidable barrier to spread.

I have been unable to get anything definite about trees, except that although the pines east and west are considered at present to be the same, their resins are different. It has also been suggested that the Dipterocarps and wild mangoes are different, but I have not been able to find a forest botanist with the requisite special knowledge of the two areas to take this further and give names. There is a consensus of opinion that there is a difference in the trees, and I have to thank those who have answered my questions to the best of their ability. The old Burma Forest Service now being scattered all over the world, it is difficult to get into touch.

As regards insects, Brig. W. H. Evans has most kindly given me the following in a letter. Capt. E. V. Watson divides butterflies into three groups:

1. Low elevations up to 2,000 ft. 288 species.
2. High elevations over 2,000 ft. 92 species.
3. All elevations, 67 species.

Group 1 is typically Burmese; one-third are Burmese not reaching India; one-sixth are north-east Indian, not going further south or east; the rest typical of Burma and India.

¹ A list of the plants collected is filed at Kew Gardens.

Group 2 is almost entirely east Himalayan. Only 7 out of the 92 reach Malaya.

Group 3: 64 fly throughout Burma, 3 do not go south of the Chin Hills. Of the 64, 2 do not go further north, 42 are of universal distribution. Four reach the west Himalayas, and 16 only reach the north-east Himalayas.

A good many north-east Indian species have been found in the Karen Hills and Shan States and *vice versa*, but always with a more or less intensified subspecific difference. Specific instances are: *Teinopalpus imperialis imperialis* becomes *T. i. imperatrix*; *Euploea klugii* becomes *E. crassa*; *Euthalia julii appiades* becomes *E. J. xiphiones*.

Brigadier Evans also tells me that two Chinese butterflies occur in the Chin Hills. They are common at Ta Tsien Lou in Szechwan and occur nowhere else in India or Burma. They are *Carterocephalus dieckmanni* at Fort White and *Abraximorpha davidii* on Mt. Victoria. The special interest of this is that I obtained a flying squirrel, *Petaurista sybilla* in the Chin Hills, a female and one young one from a nest. The only closely related species come from China. They seem to have followed the high hills round the north of the Hukawng Valley and come down the Naga-Chin Hills into Burma, perhaps living at a lower altitude in the Chin Hills than in the north, as some birds do.

4. CLINES

Another point comes out especially from the squirrels. Apart from distinct species on the two banks, there are a number of colour clines. The most striking of these is *Callosciurus sladeni* of which the typical form is found at Kindat and extends eastwards. To the north, *millardi*, *haringtoni*, *careyi*, *fryanus*, and *shortridgei* are first successively paler, almost to cream, and then go back to grey. To the south the red in *sladeni* develops it into a bright red animal, *rubex*. There is a good colour plate of these animals in the Society's Journal, xxiv, 1916. Huxley (1942) refers to them on p. 219 and 227, saying that there are two colour clines separated by a tributary, presumably the Uyu, which is not very big, but has areas of elephant grass. I am not a taxonomist, but for the field worker it is desirable to have a method of distinguishing clearly between a red, an iron grey, a cream and an olive grey animal.

Another cline is *Callosciurus erythraeus* on the west bank; from south to north, *kinneari*, *nagarum* and *crotalus* occur, and there is more than one form of each of *Ratufa gigantea*, *C. rufigenis*, *C. mearsi* and *C. macclellandi*, the old genera *Tomeutes*, *Dremomys* and *Tamiops* for which I have an old-fashioned hankering.

It seems that when distribution or spread is concentric and extends in all directions, the development of variations is prevented or at least retarded by the ability of the stock to mix with others round it. But when a linear barrier is reached, this ability to spread and mix is restricted and consequently variations have a better chance to become fixed.

It has been suggested that the colour changes in *C. sladeni* are related to the different bark on trees in each area. I did not make

observations on this point, but my recollection is that the trees remain very much the same throughout the 250 miles over which this cline exists. The play of shadows in such jungle creates a broken pattern on a self-coloured animal when at rest, and when moving, the ability of all squirrels to disappear round a tree is astonishing. Unlike an animal living in a grassy plain, a squirrel is never more than a few feet, usually only a foot, from the complete cover from observers or predators which is afforded by a tree trunk or a big branch. I have never ceased to be surprised at the way in which squirrels with an apparently obvious colouration can disappear completely in a moment; the red squirrel in Great Britain is an adept at it. Procryptic colouration is perhaps not of great importance on this account, and the tail is another thing which disturbs the aim of predators. Colour changes in these animals may therefore not be associated with habitat changes.

5. DISCUSSION

The Chindwin-Irrawaddy drainage illustrates a number of points about barriers and limits. It lies in an elongated horse-shoe of mountains, separated by low ground and running into the Himalayas in the west and into China in the east. These high hills are the primary feature of the drainage, and form both a barrier to the spread of plains species in the middle and a dispersal route for those of the hills. To take the hills first, the plains in the middle isolate the two sides from each other, and there are many differences in the eastern and western subspecies. This is not only shown by birds, but by mammals, insects and plants at least. *Rattus bowersi* is a hill species with *mackenziei* in the west and *faei* in the east, and *R. b. bowersi* in both. *R. manipulus* does not extend to the east, but is found in the Khasia Hills. Some squirrels are confined to the hills, e.g. *C. macmillani*, on the west only. *Dryonastes* is a laughing thrush with several species: *D. sannio* on the east and *galbanus* on the west between roughly 2,000 and 5,000 ft. *D. ruficollis* is found in the centre plain below 2,000 ft. Above 5,000 ft., *D. caerulatus* occurs in the east and at least in the Naga Hills and Manipur in the west. If it does not occur in the Chin Hills, it may be because the ground over 5,000 ft. is limited. But of the other three, *sannio* and *galbanus* are separated physically by the low ground while *ruficollis* is isolated by perhaps a more ecological barrier, its preference for low ground. It appears to be limited to the south by the Dry Zone. The distinction is perhaps more apparent than real as a preference for habitats between 2,000 ft. and 5,000 ft. might be thought to be ecological also. In the north-east where mountains are higher, Stanford records species which are absent from the west, such as the blood pheasants, *Ithagenes*. They are limited to ground higher than that in the west. It is well known that ranges of hills isolate hill species and tend to cause differences to develop.

In the plains and foothills the situation is somewhat different. There are considerable climatic differences between the north and the south, and the Dry Zone seems to be a barrier to some species; it has a small number of species peculiar to itself. But while there is no barrier in the north to the spread of birds within the plain